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RAIN AND/OR LOW TEMPERATURE AS FACTORS INTERRUPTING EXTERNAL BUILDING WORK IN THE LONDON AREA

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INTRODUCTION

Weather factors most commonly responsible for interrupting external building work in the London area, and probably in all parts of the British Isles, are rain and/or coldness. Building contractors sometimes wish to know (e.g. when estimating the completion date of a contract) the monthly percentage frequencies of time likely to be "lost" due to rainfall or low temperature, or to these two factors in combination.

The writer was unable to find references to any experiments designed to determine the intensity of precipitation which would be likely to cause external work to be interrupted; it is probable that the critical rate (or intensity) varies with a number of other meteorological factors, including the direction and strength of wind, temperature (not restricted to a suggested threshold of 34°F as used in this particular analysis), state of ground (e.g. flooded, snow-covered, frozen), thick fog, etc., and also with a number of non-meteorological factors. However, it was considered that helpful results would be obtained by finding the percentage of time that the rate of precipitation was 0.5 mm. per hour or more.

The results of this investigation are considered to be applicable to the Greater London area; it is hoped later to repeat the investigation using data applicable to Glasgow, Belfast, Manchester and Cambridge.

DATA

Hourly observations (punched on Hollerith cards) for London Airport for the 12-hour period 06-18 G.M.T. daily during the ten years 1949-1958 were used. It is shown later that the results are applicable to long-term average conditions, except for abnormal spells of weather.

PRECIPITATION

Intensity or rate of fall is the determining factor in classifying precipitation (rain, drizzle, snow or hail) as slight, moderate or heavy, not the total fall over a period of an hour or more, and the rate of 0.5 mm. per hour corresponds to the upper limit of slight rain. This scale of intensity needs to be increased when applied to showers, for a threshold rate of 0.5 mm./hour would probably cause practically all showers to be included in the frequencies of "appreciable" precipitation in this investigation. Special observational techniques are used to record the measurement of rainfall when all the precipitation has occurred as snow; as a rough approximation, a rate of rainfall of 0.5 mm./hour would correspond to an accumulation of snow at a rate of 6.0 mm./hour, and it seems unlikely that external building operations would have to cease because of slight snow falling for a relatively short period at this rate (perhaps with the air temperature being 34°F. or just above).

In the absence of any experimental evidence, and after discussion with the Building Research Station, D.S.I.R., it was decided that the lower limit of precipitation contributing to time lost in the Building Industry through inclement weather should be set at this rate of 0.5 mm./hr. Since this figure was somewhat

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arbitrarily fixed, no advantage was to be gained by attempting to refine the procedure or to apply weighting factors to the results in order to allow for the unnecessary inclusion of slight showers or occasions of slight snow; it seems reasonable to suppose that, as an average figure for each month over the whole year, and bearing in mind the complexity of the basic problem, the rate of 0.5 mm./hr. is not likely to be very wrong.

TEMPERATURE

Temperatures are punched on the Hollerith cards in whole degrees Fahrenheit, and that part of the analysis which deals with temperatures less than 34°F. actually uses a threshold temperature of 33.6°F. i.e. 33.6°F. would be "rounded-up" and punched as 34 whilst 33.5°F. would be punched as 33. The temperature criterion of 34°F. (actually 33.5°F.) seems to be quite reasonable, but it must be remembered that there will be occasions when the ground is frozen for several hours with the air temperature 34°F. or higher; perhaps the number of these occasions will be approximately counter-balanced by the number of occasions whem external work is able to proceed even though the air temperature is below 34°F.

HOLLERITH TABULATIONS

Four tabulations were required, namely:-

A – No. of occasions with temperature less than 34°F.

B – Total duration of precipitation falling at the rate of 0.5 mm./hr. or more.

C – No. of occasions which make up B.

D – No. of occasions in C when temperature was less than 34°F.

Tabulation B was derived from the two columns, on the punched cards, allotted to precipitation duration (in tenths of hours) and from the three columns allotted to precipitation amounts (mm. and tenths), thus:-

duration 1.0 and 0.9 hr., amount 0.5 mm. or more.
" 0.8 " 0.7 " , " 0.4 " " "
" 0.6 " 0.5 " , " 0.3 " " "
etc.

TABULATION OF RESULTS

Table 1 gives the number of hours with air temperature less than 34°F. whether or not precipitation was occurring, the total number of hours (from 6 a.m.-6 pm. daily) each month in the 10-year period, and the percentage frequency of hours with temperature less than 34°F. (See A above).

Table 2 gives the total duration, in hours and tenths, of precipitation at a rate of 0.5 mm./hr. or more, and the total number of occasions. (See B and C above.)

Table 3 gives the totals of duration of precipitation at a rate of 0.5 mm./hr. or more with temperature less than 34°F. (See D above).

DISCUSSION

The analysis deliberately ignores the incidence of weekends or holidays, i.e. it includes all days, so that the percentage of time "lost" is a more useful statistic than the number of hours "lost".

It is convenient here to consider three simplified tabulations, each applicable to the daily period 6 a.m. to 6 p.m.:-

(a) Temperature below 34°F., no precipitation at or above the rate of 0.5 mm./hr.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Percentage hours	15.1	17.1	5.9	0.2	-	-	-	-	-	1.4	3.7	10.2

(b) Appreciable precipitation (i.e. rate 0.5 mm./hr. or more), no restriction regarding temperature.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Percentage hours	3.8	5.9	3.2	2.7	3.2	2.8	3.4	3.5	3.3	4.2	4.9	3.9

(c) Temperature below 34°F. and/or precipitation at rate of 0.5 mm./hr. or more.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Percentage hours	18.9	23.0	9.1	2.9	3.2	2.8	3.4	3.5	3.3	5.6	8.6	14.1

Fig. 1 shows the above results in graphical form.

The period January 1949-December 1958 includes the unusually cold months January, February and March 1955 but excludes the winter of 1946-47, which was remarkable for an exceptionally long unbroken period of bitterly cold weather (for details see M.O.3. Climatological Memo. No.4 "A comparison of the winters of 1946-47 and 1954-55", by Mr. R. E. Booth).

The 30-yr. average 1921-50 of the mean temperature over England and Wales for the winter months December, January and February is 40.9°F. while the 10-year. average 1949-58 is 40.7°F., so that the ten winters considered in this investigation may be regarded as representative of long-term average temperature conditions. The annual rainfall over England and Wales, expressed as a percentage of average for the 35-yr. period 1916-50, for each year from 1949 to 1958 inclusive, is:-

1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
85	110	120	97	82	117	85	94	97	114%

and these values give an average over the ten years of 100%, so that on the basis of rainfall the period is representative, so far as England and Wales are concerned, of the longer 35-year standard period.

Long-period averages for London Airport are not available, but for Kew Observatory the 10-yr. average (1949-58) of daily mean temperature for the winter months December, January and February is 40.8°F., which compares very well with the values 40.9 and 40.7 given above, and the annual rainfall at Kew averaged over the ten years is 100.4% of the Kew 1916-50 rainfall average. There is no reason therefore to suppose that the temperature and rainfall data of London Airport for the period January 1949-December 1958 are not representative of long-term average conditions over the Greater London area.

The histogram (fig. 1) shows that, taking into account only two factors, the time lost through inclement weather in the building industry in the London Area is fairly constant at about 3% from April to September inclusive, and that it is over 14% from December to February, reaching a peak of 23% in February; taking each factor separately, February is again the worst month, the time lost being 5.9% on account of rainfall and 17.1% on account of low temperature.

The right-hand column of Table 2 gives the average duration, month by month, of rain at the rate of 0.5 mm./hr. or more, the average for each such occasion over the whole year being about 34 minutes. The number of occasions shown in Table 3 is too small, especially in April and December, to permit valid conclusions to be drawn, but the average duration of those occasions when the rainfall rate was 0.5 mm./hr. or more and the temperature less than 34°F. was 43 minutes in January and March, and 41 minutes in February. It should be emphasized that these are values of 'average duration', covering the short showers and relatively long periods of rain.

It may be deduced from a comparison of the values in Table 1 with those in table (a) above that the percentage of hours "lost" when the temperature is less than 34°F. and also precipitation is occurring at a rate at or above 0.5 mm./hr. is given by:-

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Percentage hours	0.9	0.7	0.3	0.1	-	-	-	-	-	-	-	0.3

The same results may be deduced from Table 3 by expressing the number of occasions as a percentage of the total hours; for the two factors (temperature and rainfall) to satisfy their respective criteria simultaneously, January is the worst month, but even then there are on average only 3.3 occasions per month, each occasion lasting a little over 40 minutes. From May to November inclusive, there were no occasions during the 10 years when precipitation fell at a rate of 0.5 mm./hr. or more and temperature was below 34°F., and during the other five months (December-April) there were, on average, only eight occasions in all.

COMMENT

It is understood that experiments will soon be conducted to try to determine the meteorological criteria for the rain and temperature conditions liable to interrupt external building work; it seems likely that these criteria will be more or less constant over the British Isles, although the critical rate of rainfall may show a seasonal variation e.g. perhaps a rate of 0.7 mm./hr. is generally tolerable in the summer whereas a rate of 0.4 mm./hr. might often induce men to take shelter in the winter.

As previously stated, there are other meteorological factors, of which wind direction and speed are thought to be most important, and many non-meteorological factors which we are not able to consider but which were referred to in a letter we received from a firm of building contractors - " ... we would expect to find variations between the persistency of different gangs reflecting the different types of work being done, the extent to which protective clothing had been issued, the tenacity of the foremen, and even on whether the men were on bonus or not".

The effect of weather on building materials is a separate problem.

Polythene shelters to cover the building site, or part of the site, obviate loss of working time due to inclement weather, and this memorandum may help contractors to decide for particular jobs whether it is an economic proposition to use them.

LONDON AIRPORT, JANUARY 1949 - DECEMBER 1958, 0600-1800 G.M.T.

TABLE 1: Frequency of hours with temperature less than 34°F. (i.e. time "lost"), irrespective of precipitation - 10 year period.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Total hours	3720	3384	3720	3600	3720	3600	3720	3720	3600	3720	3600	3720
No. of hours "lost"	595	601	231	12	-	-	-	-	-	51	133	390
Percentage hours	16.0	17.8	6.2	0.3	-	-	-	-	-	1.4	3.7	10.5

TABLE 2: duration of precipitation at rate 0.5 mm./hr. or more, irrespective of temperature - 10 year period.

Month	Total hours 06-18 G.M.T.	Rainfall duration at rate 0.5 mm./hr. or more, in hours & tenths	Percentage duration	No. of occasions	Average duration of rain at rate 0.5 mm./hr or more, per occasion, in minutes
Jan.	3720	141.2	3.8	235	36
Feb.	3384	198.1	5.9	314	38
Mar.	3720	118.3	3.2	209	34
Apr.	3600	95.9	2.7	185	31
May	3720	120.4	3.2	240	30
June	3600	99.5	2.8	197	31
July	3720	124.6	3.3	269	28
Aug.	3720	130.8	3.5	285	28
Sept.	3600	120.0	3.3	247	29
Oct.	3720	154.9	4.2	248	37
Nov.	3600	175.7	4.9	284	37
Dec.	3720	144.8	3.9	221	40

TABLE 3: duration of precipitation at rate 0.5 mm./hr. or more, with temperature less than 34°F. - 10 year period.

Month	Total hours 06-18 G.M.T.	Rainfall duration at rate 0.5 mm./hr. or more, and air temperature below 34°F.	No. of occasions	Average duration (minutes)
Jan.	3720	23.8 hr.	33	43
Feb.	3384	14.3	21	41
Mar.	3720	8.5	12	43
Apr.	3600	3.9	5	-
Dec.	3720	7.8	9	-

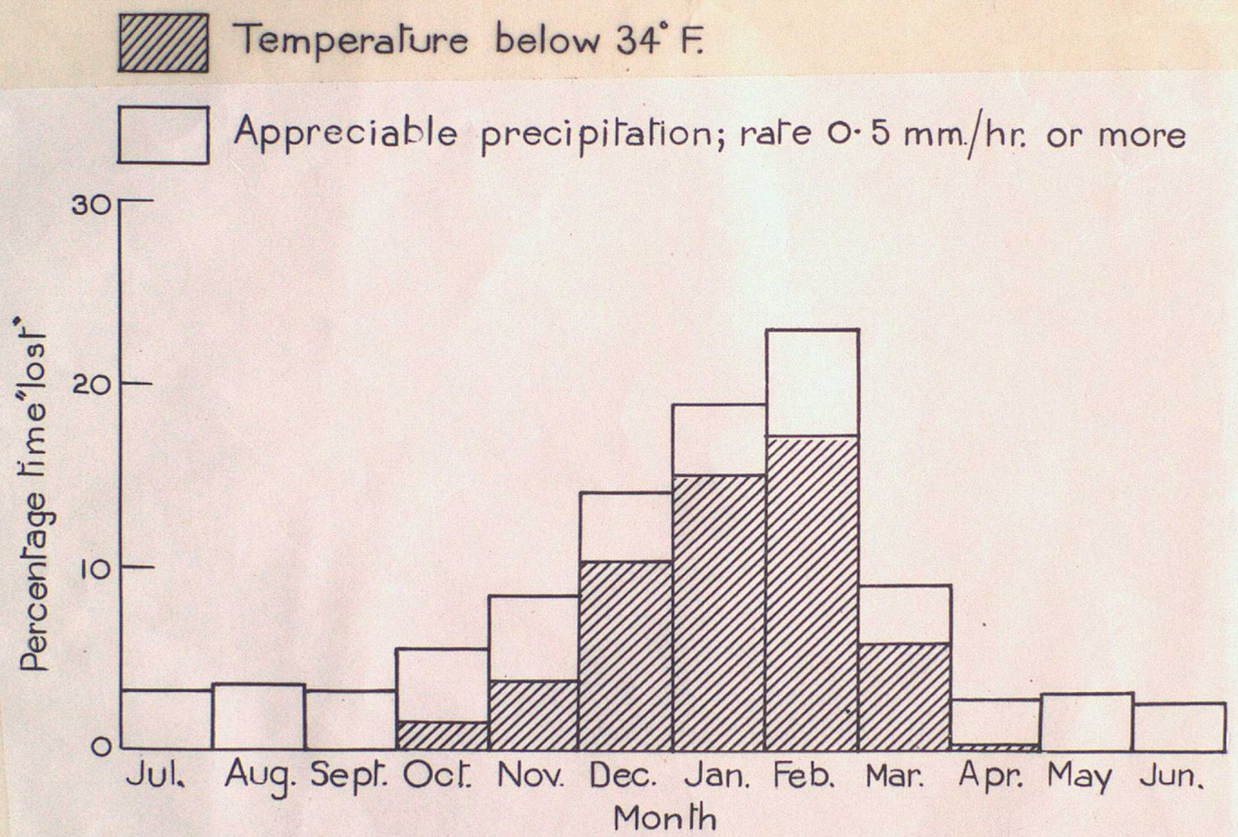

Fig.1— Percentage time "lost" due to rain and/or low temperature interrupting external building work in the London area